Appendix A Technical Issues

The design and information presented in this Pre-Proposal are not fixed or complete. A number of technical issues that are currently under study, both at Los Alamos through LDRD funding, and by the collaboration, are described in this Appendix. None of these issues will prevent the project from achieving its goals, but, rather, they are matters of technical optimization.

An important question is whether it will be possible to incorporate ferromagnetic shielding at temperatures below 4 K. If possible, the size of the low-temperature magnetic shield and ^{4}He volume could be substantially reduced. The use of ferromagnetic shielding is preferable to superconducting shielding when a homogeneous field within the shield is required. The boundary condition for a superconductor cancels the field from a current carrying wire placed against it so there has to be a substantial spacing of the field generation wires from the shield surface. On the other hand, the boundary condition for an ideal high permeability ferromagnetic material is such that the field from a constant pitch winding on the inner surface is perfectly homogeneous [1]. A study of amorphous ferromagnetic materials is currently in progress.

The T_1 and T_2 lifetimes of polarized ^{3}He for wall coatings compatible with UCN storage must be studied. Previous work has largely focussed on cesium coated cells; this coating is incompatible with UCN. On the other hand, long ^{3}He polarization lifetimes have been obtained with solid hydrogen coated cells. This would suggest the possibility that frozen deuterium would be a mutually compatible wall coating. This issue remains to be studied, as well as the technology associated with transport of polarized ^{3}He to cell; in this case, cesium coating can be used. The UCN polarization lifetime of these materials remains to be investigated; while there is essentially no useful experimental or theoretical information in the literature regarding this question, a simple estimate suggests that the depolarization per wall collision should be much less than 10^{-5}. This is supported by recent experimental and theoretical work by the UCN A Coefficient Collaboration.

There are a number of issues associated with the scintillation light that require study. One question is whether the afterpulses from the He_2 dimers can be used for event identification. This technique, in principle, could improve the signal-to-noise by discriminating beta decay and gamma backgrounds from the ^{3}He-UCN reaction signal. Also there is only scant information regarding high voltage effects on scintillations. In particular, the effects of high voltage on our proposed storage cell geometry must be experimentally studied. One possible effect is that continuous microdischarges might generate intense background light that swamps the desired scintillation signal.

Other questions regarding the high voltage effects on the cell include the field homogeneity, charge buildup on the inner surfaces, and the magnitude of field that can be stably achieved. These are questions that we will study over the next year. A method of measuring the *in situ* field by use of the Kerr effect in liquid helium is under development at U.C. Berkeley.

The design of the cold neutron beam splitter and polarizer are also presently being studied. In principle, it should be possible to split into two oppositely polarized beams, and each of these directed to either of the cells (with a spin flipper in one beam), thereby utilizing the entire cold neutron flux. In practice, based on our initial calculations, the length required for the spin separation and beam redirection is quite large, precluding its use at LANSCE. Such a system, if successful, would increase the number of stored UCN by up to a factor of two. It might be possible to use a Soller [2] configuration of multiple curved supermirror polarizer plates to reduce the length. On the other hand, traditional neutron beam polarization techniques that absorb the "wrong" spin state can be used within the available space at LANSCE.

Appropriate valves, possibly superfluid tight, that do not relax the ^{3}He polarization must be developed.

Although we have experimentally investigated the diffusion and distribution of ^{3}He in a superfluid filled cell, this work was done at comparably high concentration. Issues of spin diffusion, temperature gradient effects, and spatial distribution at very low concentrations remain to be studied. We are considering measurements using tomography with polarized ^{3}He and a polarized cold neutron beam to study spin diffusion.

The "dressed spin" technique as discussed in the Physics Report [3] offers up to a factor of three increase in sensitivity. We did not discuss this technique in this Pre-Proposal because of the added complication. However, this technique could be studied using polarized 3He stored in a cell and a polarized cold neutron beam. We plan to design an experiment that will be compatible with this technique and incorporate it after we have a convincing demonstration of the SQUID based system.

[1.] I.B. Khriplovich and S.K. Lamoreaux, *CP Violation Without Strangeness* (Springer-Verlag, Heidelberg, 1997). See pp. 40-41.

[2.] J.M. Hayter, J. Penfold, and W.G. Williams, Jour. Phys. E **11**, 454 (1978).

[3.] R. Golub and S.K. Lamoreaux, Phys. Rep. **237**, 1 (1994).